Flow Battery Storage Application with Wind Power

Mark T. Kuntz
VP Marketing & Business Development
mkuntz@vrbpower.com

California Energy Commission Staff Workshop:
Meeting California's Electricity System Challenges through Electricity Energy Storage
February 24, 2005

Two Cases for Wind-Coupled Storage

- **Remote Area Power Systems: King Island, Australia Installation**

- **Grid-Connected Systems: Edom Hills Wind Park Prospectus**

Remote Area Power Systems

- **Cost of supplying fuel is high**
- **Frequent operation of gensets at part-load for spinning reserve and load following increases fuel usage and emissions**
- **Wind power or other renewable sources can be intermittent and unpredictable**

Storage Captures More of the Wind

- **Flow battery stores:**
  - **wind energy that exceeds load, especially off-peak**
  - **wind surges**
- **Stored energy is released during high demand**

Burn Less Fuel, Create Fewer Emissions

- With storage, diesel plant can be run at peak output most of the time
  - Gensets clock fewer run-hours
  - Less maintenance is required
  - Fewer emissions are released into the environment

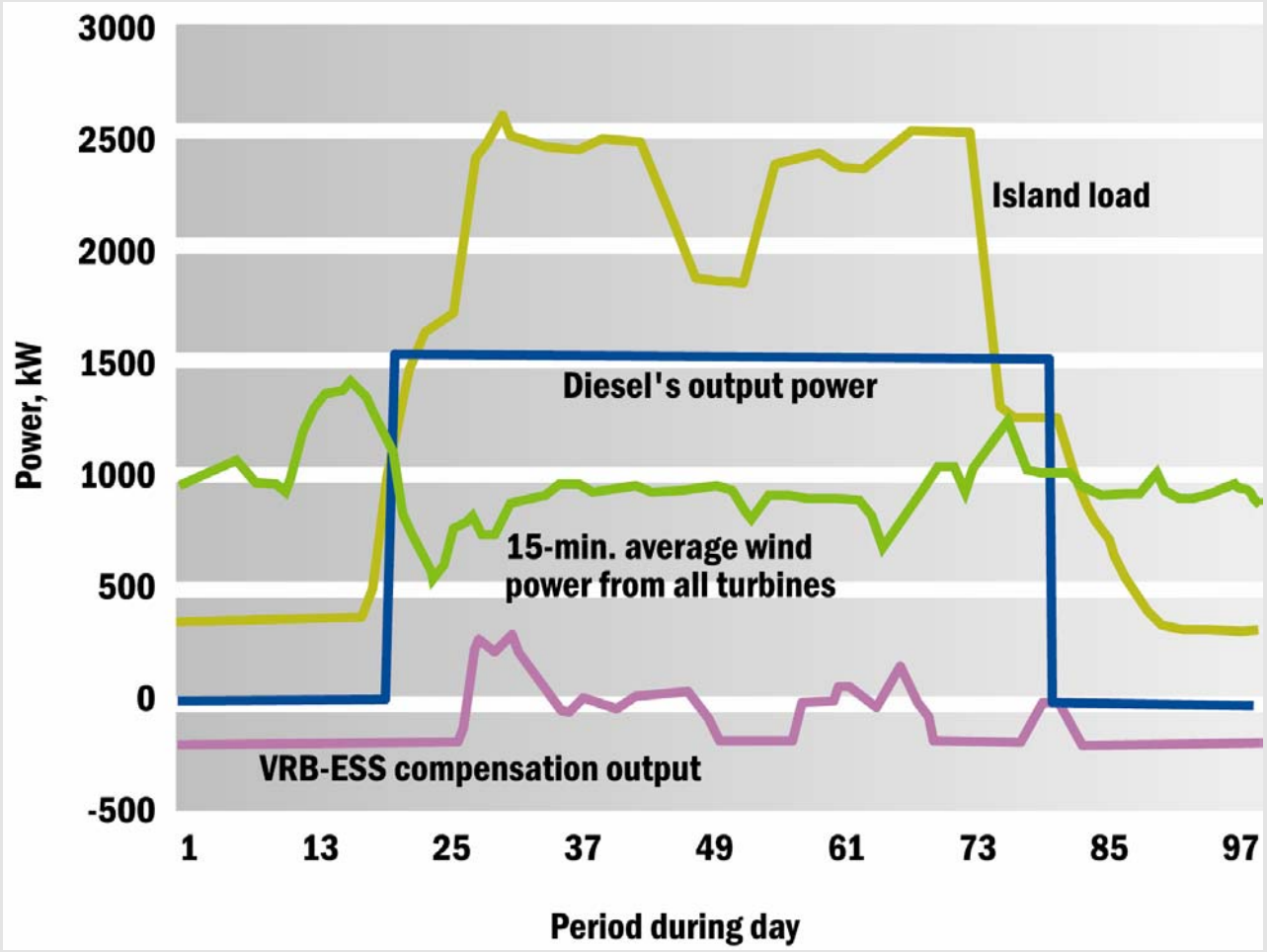
Case Study: King Island

- Four existing 1,500-kW diesel engine generators
- Three existing 250-kW wind turbines
- Two 850-kW wind turbines added along with storage
- Wind regime is excellent but does not coincide with island's electrical load

Flow Battery Wind-Diesel Installation at King Island

Inside the Flow Battery Installation at King Island

Energy Storage Optimizes Performance



King Island Project Benefits

- **Reduces emissions**
  - **4,000,000 kg/year CO_2**
  - **99,000 kg/year NO_x**
  - **75,000 kg/year unburned hydrocarbons**

King Island Project Benefits

- **Capture “spilled” wind - $51,200/y**
- **Reduce spinning reserve - $91,500/y**
- **Improve operating efficiency - $83,200/y**
- **Reduce maintenance - $23,000/y**

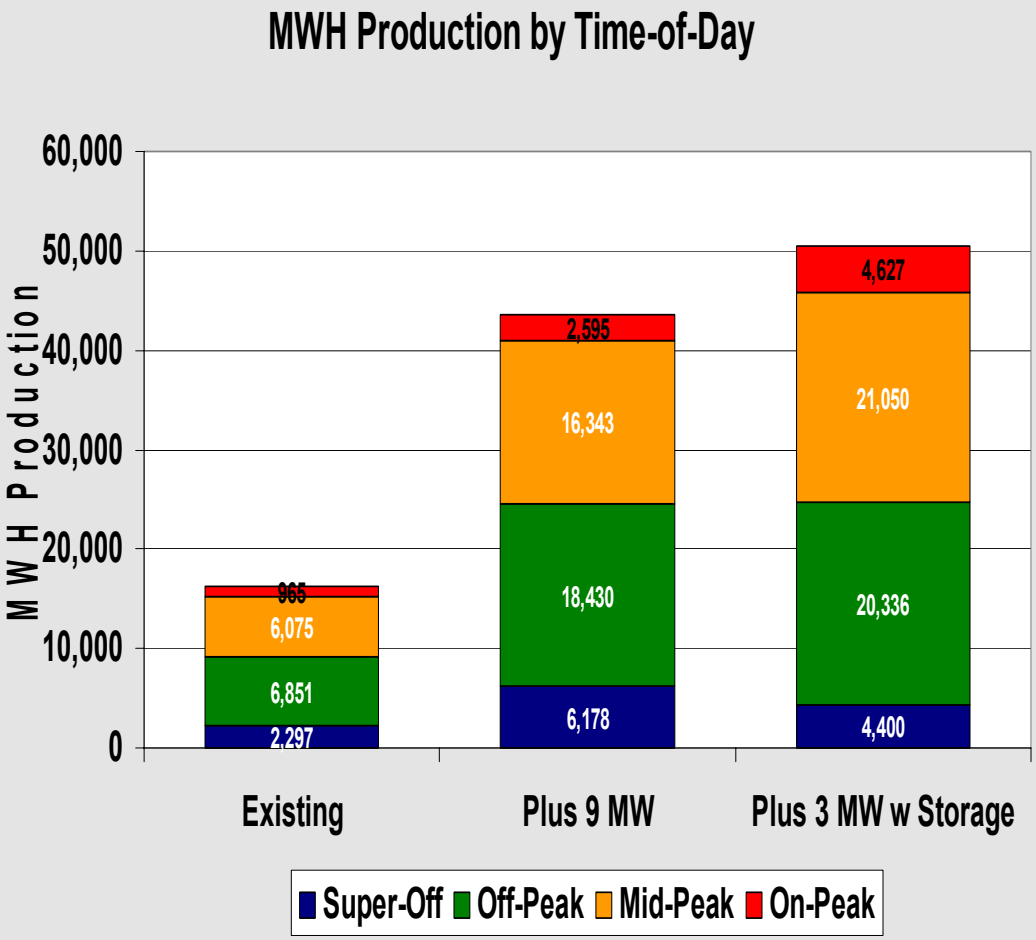
- **TOTAL: $248,900/y, 3.5 year payback**

Grid-Connected Application

- Thousands of wind turbines around the world are nearing the end of their productive lives.
- New turbines offer superior efficiency and reliability with lower avian mortality.
- Interconnect hardware and legacy power purchase agreements constitute a “hard ceiling” on the size of a repowered wind farm.
- Energy storage enables developers to break through this ceiling and offers the following benefits:
  - Wind plant size can exceed substation rating (ceiling)
  - Better overall capacity factor on existing grid assets
  - Time-shift energy to peak periods
  - Create capacity value
  - Power factor correction and grid stability improvement.

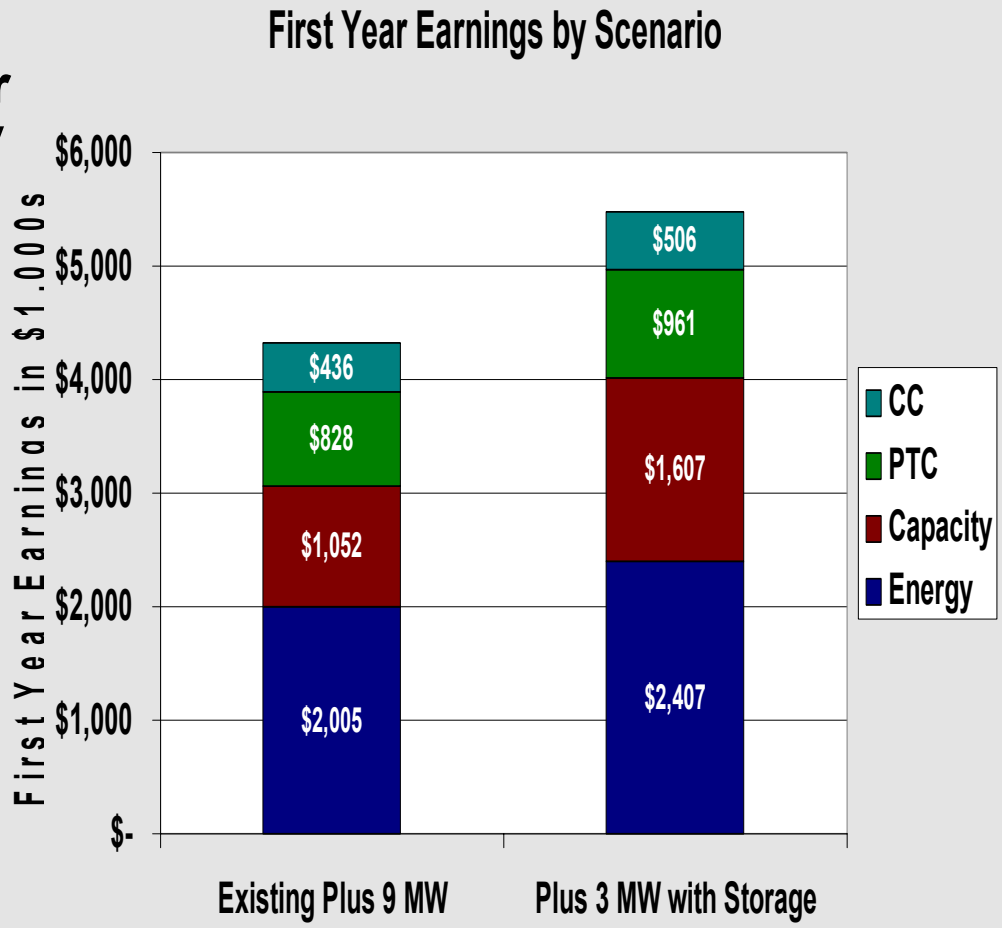
San Gergonio Wind Farm

- 20 MW interconnect and PPA, but only 11 MW built
- Original plan called for adding 9 MW
- Storage allows additional 3MW to be added, with benefits as follows:
  - Total energy production increased by 6,877 MWH/year (16%)
  - On-peak energy production and capacity increased by 2,032 MWH/year (78%)
  - Power factor correction inherent in storage system



San Gergonio Wind Farm Economics

- **Revenues increased over base repowering case by $1,160,000/year (27%) consisting of;**
- **Capacity payment increased by $555,000/year (53%)**
- **Annual $50,000 station service charge eliminated**
- **Retrofit of $65,000 in power factor equipment avoided**
- **Storage system unleveraged, before-tax IRR = 11%**



Conclusions

- **Flow Batteries provide large-scale energy storage that is available today**
- **Flow Batteries can increase the value and functionality of wind resources**
- **Flow Batteries can improve the utilization of existing electrical infrastructure while enhancing power quality and reliability**
- **Flow Batteries are an environmentally responsible battery technology**